



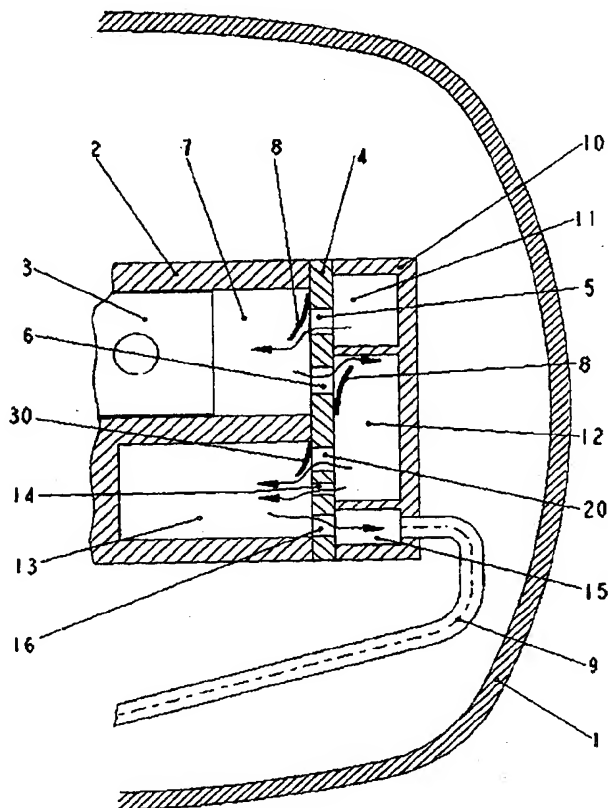
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/BR99/00026 <b>(22) International Filing Date:</b> 12 April 1999 (12.04.99)  <b>(30) Priority Data:</b> PI 9803517-7      13 April 1998 (13.04.98)      BR  <b>(71) Applicant (for all designated States except US):</b> EMPRESA BRASILEIRA DE COMPRESSORES S.A. - EMBRACO [BR/BR]; Rua Rui Barbosa, 1020, CEP-89219-901 Joinville, SC (BR).  <b>(72) Inventor; and</b> <b>(75) Inventor/Applicant (for US only):</b> FOGOTTI, Fabian [BR/BR]; Apartamento 701, Rua Orestes Guimarães, 421, CEP-89219-901 Joinville, SC (BR).  <b>(74) Agents:</b> ARNAUD, Antonio, M., P. et al.; Rua José Bonifácio, 93, 7º andar, CEP-01003-901 São Paulo, SP (BR).		<b>(81) Designated States:</b> CN, JP, KR, MX, SG, TR, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** A DISCHARGE ARRANGEMENT FOR A HERMETIC COMPRESSOR

**(57) Abstract**

A discharge arrangement for a hermetic compressor, comprising a fluid communication means (14, 20, 30) between a first discharge chamber (12), receiving an intermittent gas mass flow from a compressor chamber (7), and a second discharge chamber (13), said fluid communication means having its cross section dimensionally and selectively variable, as a function of the pressure differential between the first and the second discharge chambers (12, 13).



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## A DISCHARGE ARRANGEMENT FOR A HERMETIC COMPRESSOR

Field of the Invention

The present invention refers to a constructive  
5 arrangement applied to the discharge system of a small  
reciprocating hermetic compressor, such as that used  
in refrigeration systems.

Background of the Invention

Reciprocating hermetic compressors consist, in  
10 general, of a motor-compressor assembly mounted inside  
a hermetically sealed shell.

These compressors are usually provided with a cylinder  
and a piston, which reciprocates, taking in and  
compressing the refrigerant gas when driven by the  
15 electric motor. The actuation of the piston produces  
an intermittent flow of refrigerant gas which tends to  
produce noise, requiring the provision of acoustic  
attenuation systems both on the suction side and on  
the discharge side of the compressor.

20 Among the known techniques for the attenuation of  
noises, particularly those existing on the discharge  
side of the compressor, it is known the use of filters  
or discharge acoustic mufflers, where the compressed  
gas coming from the compressor is expanded, reducing  
25 the pressure thereof. The discharge muffler further  
has the purpose of attenuating the pulsation of the  
gas pumped by the compressor and which causes  
excitation in the ducts and components to which the  
compressor discharge is coupled, generating noise.

30 In general, the discharge mufflers make the gas flow  
pass through a sequence of ducts, volumes and  
localized restrictions, whose dimensions, disposition  
and particular characteristics depend on the  
application, type and size of the compressor, mass  
35 flow, working fluid, temperature and operational

conditions, etc..

- Before starting to operate, the compressor is usually submitted to a null pressure differential between the suction and the discharge sides. This common pressure
- 5 is called equalized pressure and its value is a direct function of the design characteristics of the system, of the type of refrigerant fluid and lubricant used and of the temperatures to which the assembly is submitted.
- 10 Since there is not a pressure differential between the suction and the discharge sides, the mass flow which is established at the beginning of the compressor operation is always high, usually with an order of magnitude superior to the mass flow under a normal
- 15 operational regime. The higher the density of the working fluid, i.e., the higher the value of the equalized pressure and the lower the fluid temperature, higher will be the value of the mass flow.
- 20 The tubes and the localized restrictions existing in the discharge muffler cause an energy loss in the working fluid flow with a variation proportional to the mass flow.
- The power required by the compressor motor is the sum
- 25 of the powers required to overcome the attrition forces which appear upon moving the driving mechanism plus the powers required to compress and pump the gas through the mufflers. Said power is directly associated with the energy loss of the mass flow.
- 30 Under a normal operational condition, the mass flow is such that the power required to pump the gas through the mufflers is low, as compared to the other power requirements. However, in a starting condition, such values may be compared with each other.
- 35 The components of the compressor are designed to give

maximum efficiency when operating under a normal operational regime. In the case of the motor, there is a negative association between the maximum available power and the maximum efficiency that may be obtained.

5 This is also true regarding the maximum available power and motor cost. Thus, it is always interesting to reduce the requirement of maximum motor power associated with operational conditions with high mass flow, which usually occurs when the compressor starts.

10 In these conditions, the designs of the motor and the discharge muffler are interrelated. The discharge muffler implies, intrinsically, gas flow restriction to the gas flow (energy loss). The higher the mass flow, the higher will be said energy loss. If this

15 energy loss is reduced, the requirement for maximum power required from the motor is less rigid, resulting in a project with the possibility of obtaining more efficiency and/or lower costs. However, a muffler producing less energy losses will certainly be less

20 efficient in terms of noise and pulsation dampening.

#### Disclosure of the Invention

Thus, it is an object of the present invention to provide a discharge arrangement for a hermetic compressor, which allows to reduce the power used for

25 pumping the gas under high mass flow conditions, without however modifying the characteristics of said compressor under mass flow conditions in a normal operational regime.

This object is achieved by a discharge arrangement for

30 a hermetic compressor of the type comprising within a hermetic shell: a cylinder block defining a compression chamber; a first discharge chamber receiving an intermittent gas mass flow from the compression chamber; a second discharge chamber; and a

35 fluid communication means, communicating said first

and second discharge chambers and having its cross-section dimensionally and selectively variable, as a function of the pressure differential between the first and the second discharge chambers, in order to control the value of said pressure differential during the compressor operation, in order to maintain the attenuation of noises in said second chamber and the energy loss through said fluid communication means within predetermined values, under different mass flow conditions of the compressed gas received in the first discharge chamber.

#### Brief Description of the Drawings

The invention will be described below, with reference to the attached drawings, in which:

Figure 1 shows, schematically, a sectional view of part of the cylinder block and cylinder head, where is found the piston and where are defined the suction and discharge chambers of the hermetic compressor constructed according to the prior art;

Figure 2 shows, schematically and as in figure 1, a sectional view of part of the cylinder block and cylinder head, where is found the piston and where are defined the suction and discharge chambers of the hermetic compressor constructed according to the present invention; and

Figure 3 shows, schematically, an enlarged view of part of figure 2, illustrating a constructive variant of the present invention.

#### Best Mode of Carrying Out the Invention

According to the figures, the hermetic compressor of the present invention comprises, within a hermetic shell 1, a motor-compressor assembly including a cylinder block in which a cylinder 2 lodges a piston 3, which reciprocates inside the cylinder 2, taking in and compressing the refrigerant gas when driven by the

electric motor of the compressor.

Cylinder 2 has an open end, which is closed by a valve plate 4 affixed to the cylinder block and provided with a suction orifice 5 and a discharge orifice 6, said cylinder defining, between the top of the piston 3 and the valve plate 4, a compression chamber 7.

The cylinder block further carries a cylinder head 10, affixed onto the valve plate 4, in order to insulate the high and the low pressure sides and defining, internally, a suction chamber 11 and a first discharge chamber 12, which are maintained in selective fluid communication with the compression chamber 7, through the respective suction orifice 5 and discharge orifice 6.

This selective communication is defined by the opening and closing of a suction valve and a discharge valve, both in the form of a vane 8 and each acting in a respective suction orifice 5 and discharge orifice 6.

The hermetic shell 1 further carries a discharge duct or tube 9, having an internal end opened to the discharge chamber 12 and an opposite end, not illustrated, opened to an orifice provided on the surface of the hermetic shell 1, communicating said first discharge chamber 12 (or discharge muffler) and the compression chamber 7 with the high pressure side of a refrigeration system to which the compressor is connected.

In the prior art construction, illustrated in figure 1, the mass flow of the gas compressed in the compression chamber 7 is directed to the first discharge chamber 12, upon opening of the discharge valve, being then conducted to the high pressure side of the refrigeration system to which the hermetic compressor is connected through a second discharge chamber 13 provided in the cylinder block 2 and

maintained in constant fluid communication with the first discharge chamber 12 through a fluid communication means defined by a first gas passage 14, which is constantly open and in the form of, for example, an orifice provided in the valve plate 4 and dimensioned to provide a determined mass flow rate of compressed gas to the second discharge chamber 13. The second discharge chamber 13 also maintains a continuous fluid communication with a discharge sub-chamber 15 defined in the cylinder head 8 through a gas passage orifice 16 which receives and affixes the internal end of the discharge tube 9.

The first and second discharge chambers 12 and 13 act as discharge dampening elements of the discharge system of the hermetic compressor.

After passing through the second discharge chamber 13, the mass flow of compressed gas is guided to the exterior of the compressor with its pulsation being already considerably attenuated through the discharge tube 9, which produces a restriction to the gas flow, implying an additional dampening to the pulsation.

This gas discharge system of the prior art has as deficiency a high energy loss upon the compressor start or under special higher mass flow conditions to which the compressor may be subjected during short time intervals.

The present invention provides a discharge arrangement for the compressor, comprising a fluid communication means, whose cross-section is dimensionally and selectively variable, as a function of the pressure differential communicating the first and the second discharge chambers 12, 13, in order to control the value of said pressure differential during the compressor operation, so as to maintain the attenuation of noises in said second discharge chamber



and the energy loss through said fluid communication means within predetermined values, in different mass flow conditions of the compressed gas received from the first discharge chamber.

5 The discharge arrangement of the present invention allows to reduce the power used to pump gas under high mass flow conditions, without however changing the characteristics thereof under mass flow conditions existing under a normal operational regime. Thus,  
10 there is less power required from the motor upon the compressor start, without negatively affecting the performance regarding noise and pulsations under normal operational conditions.

According to the present invention, the fluid  
15 communication means comprises, for instance, a gas passage in the form of an orifice provided in a wall which is common to both the first and the second discharge chambers 12, 13, said wall being defined, in the illustrated construction, by the valve plate 4, in  
20 order to allow the selective fluid communication between the first and the second discharge chambers 12, 13.

In one of the illustrated constructions (figure 2), the fluid communication means comprises, besides the  
25 first gas passage 14, at least one second gas passage 20, further comprising a valve element 30 provided between the first and the second discharge chambers 12, 13, in order to provide, as a function of the pressure differential therebetween, the selective  
30 dimensional variation of the cross-section of the fluid communication means.

In a constructive option (figure 3), the gas passage means has a single gas passage, which is dimensioned as a function of determined mass flow conditions and  
35 downstream thereof being mounted the valve element 30,

in order to maintain said gas passage constantly open during any operational condition of the compressor, the dimensional variation of the cross-section of the fluid communication means being obtained as a function  
5 of the mass flow between the first and the second discharge chambers 12, 13.

In the constructive embodiment illustrated in figure 2, the valve element 30 is mounted downstream the second gas passage 20, in order to vary the cross-  
10 section thereof as a function of the pressure differential between the first and the second discharge chambers 12, 13.

According to this constructive embodiment, the valve element 30 is, for example, in the form of a blade or  
15 vane, which is displaceable between a closing condition, seated against a valve seat defined on the valve plate 4, in the region of the orifice provided therein which defines the second gas passage 20, in order to block the mass flow of the gas compressed by  
20 the latter, and an opening condition, defined by the spacing of an end portion of the longitudinal extension of the valve element 30 from said valve seat, on order to allow the passage of a mass flow of gas through the passage 20.

25 In this construction, the valve element 30 is conducted to the opening condition, when the pressure differential (or mass flow) communicating the first and the second discharge chambers 12, 13 corresponds to a pressure differential of compressor start  
30 sufficient to change the seating condition of the valve element 30 on the valve seat.

The closing condition is obtained when the pressure differential between the discharge chambers 12, 13 corresponds to a pressure differential of normal  
35 operation of the compressor and should be maintained

while the pressure in the first discharge chamber 12 does not reach a value which results in a determined pressure differential.

In order to guarantee that the closing and opening  
5 conditions of the valve element 30 occur under the preferred pressure differential conditions, said valve element 30 incorporates, for example, a spring element constantly forcing it to the closing condition.

In a constructive embodiment for the valve element 30,  
10 the latter is in the form of a blade, having part of its extension, which is located close to its end affixed to the valve plate 4, plastically deformed, defining a bend which is substantially transversal to the longitudinal axis thereof and which defines the  
15 spring element that forces it to the closing condition.

In an alternative of the present invention (not illustrated), the first gas passage is defined in the form of a throughbore in the valve element 30, said  
20 throughbore being positioned in a portion of the valve element 30 in such a way as to be, when the latter is seated onto the valve plate 4, vertically aligned, for instance concentrically aligned, with the orifice that defines the second gas passage 20 in the valve plate  
25 4.

Under higher mass flow conditions, the pressure differential between the first and the second discharge chambers 12, 13 tends to increase, resulting in a force upon the valve element 30 higher than a  
30 pre-tensioning imposed by the construction of said valve element and which maintains it in a closing condition, in which it is seated on the valve plate, obtaining the opening of the second gas passage 20.

In this opening condition, the mass flow of the  
35 compressed gas is deviated from the larger restriction

obtained by the first gas passage 14, under normal operation of the compressor.

The second gas passage 20 and the valve element 30 are designed so that their joint actuation results in an energy loss, during the compressor start or under special higher mass flow conditions to which the compressor may be submitted during short time intervals, which is considerably lower than the energy loss imposed by the restriction of the first gas passage 14, making the displacement of the mass flow of the compressed gas occur, preferably, through the second gas passage 20. Under this condition, the energy loss of the gas flow is minimized and, consequently, the power or the torque required by the motor.

The opening of the valve element should only occur under specific conditions, that is, only when there is a high mass flow. In a normal operational regime, the valve element should remain closed, making the mass flow of the compressed gas reach the first and the second discharge chambers 12, 13 through the first gas passage 14.

Thus, when the gas mass flow upon the compressor start is high, establishing a high pressure differential, the valve element 30 opens, reducing the power required by the motor in this situation and making viable the optimization of the design thereof.

## CLAIMS

1. A discharge arrangement for a hermetic compressor of the type comprising within a hermetic shell (1): a  
5 cylinder block defining a compression chamber (7); a first discharge chamber (12) receiving an intermittent gas mass flow from the compression chamber (7); a second discharge chamber (13); and a fluid communication means (14, 20, 30), communicating said  
10 first and second discharge chambers (12, 13), characterized in that said fluid communication means (14, 20, 30) has its cross-section dimensionally and selectively variable, as a function of the pressure differential between the first and the second  
15 discharge chambers (12, 13), in order to control the value of said pressure differential during the compressor operation, so as to maintain the attenuation of noises in said second chamber and the energy loss through said fluid communication means  
20 within predetermined values, under different mass flow conditions of the compressed gas received in the first discharge chamber (12).
2. A discharge arrangement, as in claim 1, characterized in that the fluid communication means  
25 (14, 20, 30) comprises at least one valve element (30), which is sensitive to said pressure differential, in order to provide said selective dimensional variation of the fluid communication means.
- 30 3. A discharge arrangement, as in claim 2, characterized in that the fluid communication means (14, 20, 30) comprises a gas passage, which is constantly open and in which is mounted the valve element (30).
- 35 4. A discharge arrangement, as in claim 2,

characterized in that the fluid communication means comprises a first gas passage (14) which is constantly open, and at least one second gas passage (20), the valve element (30) being mounted in the second gas passage (20), in order to vary the gas flow therethrough, as a function of said pressure differential.

5  
10 5. A discharge arrangement, as in claim 4, characterized in that each of the first and the second gas passages (14, 20) is provided in a wall portion, which is common to both the first and the second discharge chambers (12, 13).

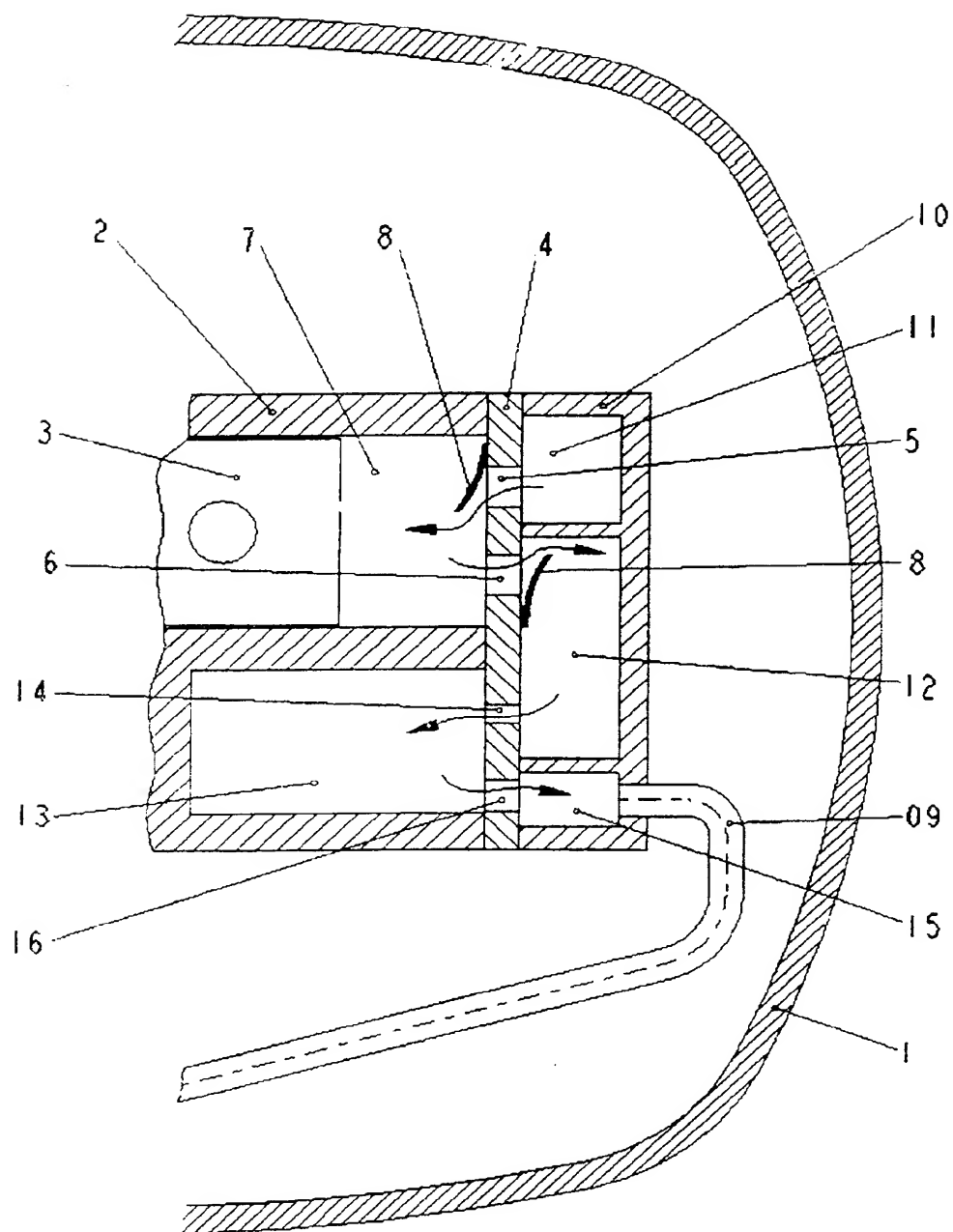
15 6. A discharge arrangement, as in claim 5, characterized in that the valve element (30) has a closing condition, which is defined when said pressure differential corresponds to a pressure differential of normal operation of the compressor, and an opening condition, which allows the passage of the gas flow through the second gas passage (20) and which is  
20 defined when said pressure differential corresponds to a pressure differential of compressor start.

25 7. A discharge arrangement, as in claim 6, characterized in that the valve element (30) is constantly forced to the closing condition by a spring element.

8. A discharge arrangement, as in claim 7, characterized in that the valve element (30) is a flexible vane.

30 9. A discharge arrangement, as in claim 8, characterized in that the valve element incorporates the spring element.

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**FIG.1**  
PRIOR ART

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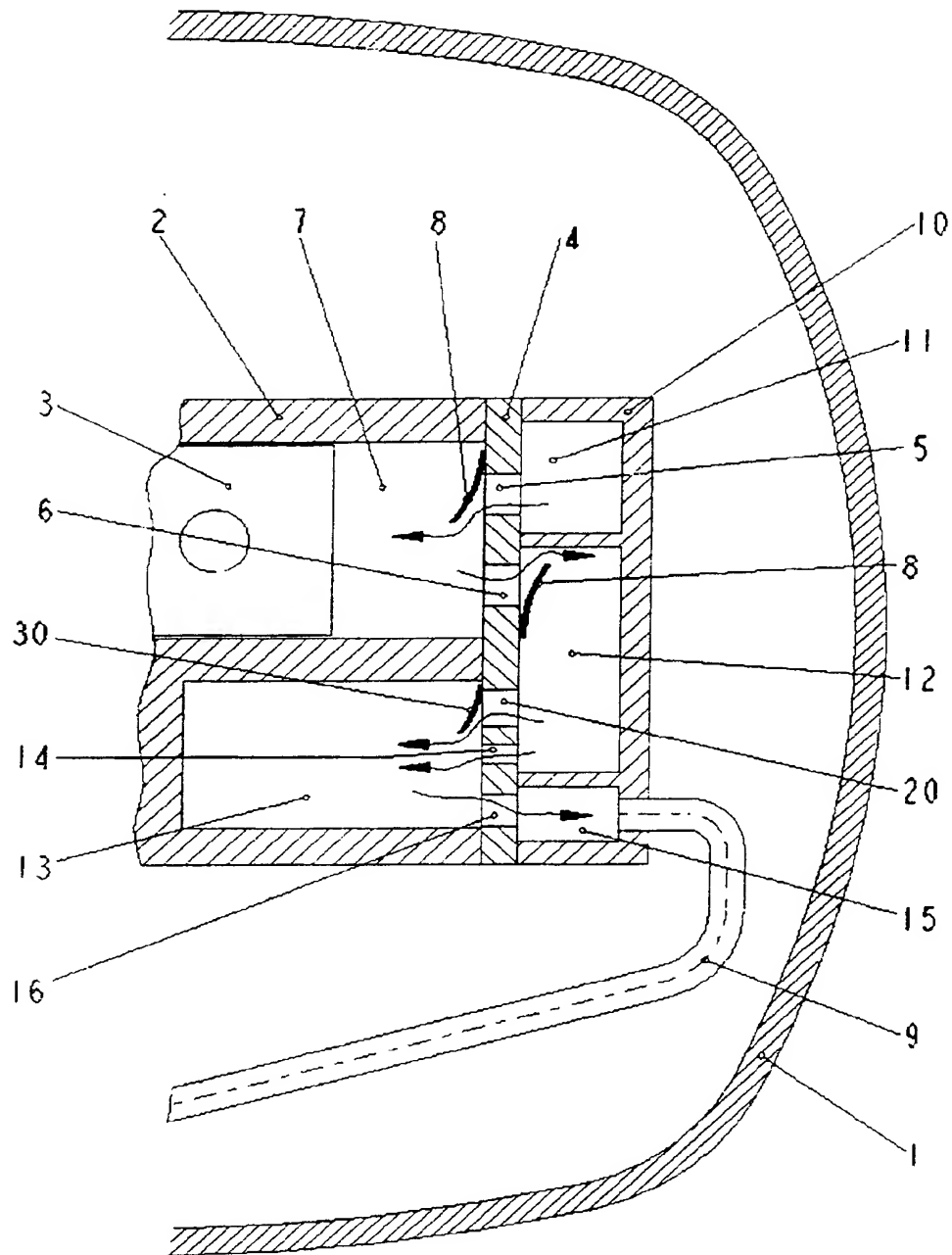


FIG.2



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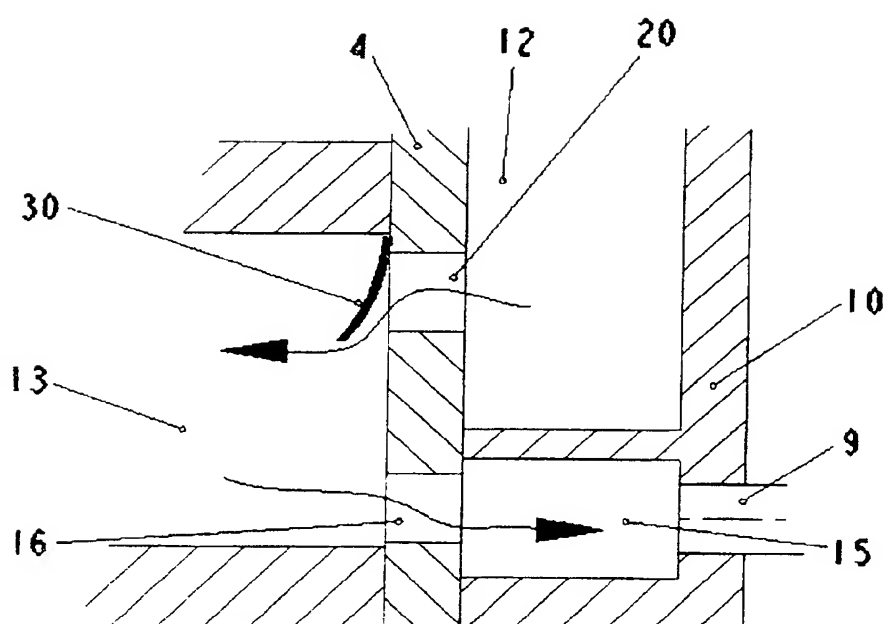


FIG.3

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/BR 99/00026

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 F04B39/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 112 198 A (SKINNER TIMOTHY J) 12 May 1992 (1992-05-12) abstract column 1, line 66 - column 6, line 5 column 6, line 50 - column 7, line 58 figures 1-4	1,2,4-9
A	FR 1 051 655 A (ÉLECTRO-INDUSTRIEL DU SUD-EST) 18 January 1954 (1954-01-18) the whole document	1,2,7
A	US 5 703 336 A (PARK SUNG OUN ET AL) 30 December 1997 (1997-12-30) abstract column 2, line 62 - column 3, line 48 figure 4	1

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

14 July 1999

Date of mailing of the international search report

27/07/1999

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# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>WO 94 27047 A (BRASIL COMPRESSORES SA ;LILIE DIETMAR ERICH BERNHARD (BR)) 24 November 1994 (1994-11-24) abstract figure 2</p> <p>-----</p>	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

In. tional Application No

PCT/BR 99/00026

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